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Abstract

The electrical and electronic waste generated by consumers in developed economies is often illegally exported to countries such as India, Ghana, or Nigeria, where it is inadequately treated in ways that harm local populations. A number of developed economies have constituted legislation to address current increases in electronic waste. The European Union and the United Kingdom (UK) have, for example, adopted the Waste Electrical and Electronic Equipment (WEEE) Directive. Despite this Directive, there are still significant environmental and health impacts experienced in the aforementioned recipient countries. Different approaches to address this problem are apparent; though, each approach comes with significant financial costs that are linked to investments in facilities, such as recycling infrastructure. The authors of this article aim to add to the understanding of the problem and to enhance the literature by seeking answers to two key questions: (1) Are consumers of electronic goods willing to bear the costs of proper disposal? and (2) To what extent does information influence electronic goods consumers' willingness to pay (WTP)? Using the contingent valuation method (CVM), the authors developed four hypothetical market scenarios outlining different strategies to tackle the electronic waste treatment problem. These scenarios were then tested on a representative sample of the UK population. The findings of this study show a decrease in median WTP after information was provided in each treatment. In addition, the results from the regression analysis suggest a positive correlation between information and WTP for scenarios where the proceeds of the electronic waste tax are used in a way that is personally relevant to the consumer.

Keywords*: International Relations, Behavioural Insights, Altruism, Environmental Economics, Circular Economy, Electrical and Electronic Waste, WEEE, Information Effect, Willingness To Pay (WTP), Contingent Valuation, Payment Card.*

[1] For all questions, including requesting a copy of the survey, please contact Abderrahim Assab at abderrahim.assab@gmail.com and Alexandra Imirziadis at aimirziadis@laingorourke.com.

I. Introduction

Negative Externalities from Electrical and Electronic Equipment Waste Treatment

Electrical and electronic waste is one of the fastest growing sources of waste streams in the European Union (European Commission 2015), as well as a pollution externality of Information Technologies (IT) industries (Baldé et al. 2015)[2]. Electrical and electronic equipment is generally comprised of components with high economic value that can be recovered and recycled (Ongondo, Williams, and Cherrett 2011). However, increasing demands for electrical and electronic equipment—due to worldwide population growth, higher levels of income, higher standards of living, and more widespread access to technology (Osslbanjo and Nnorom 2007)—coupled with persistent waste management problems, suggest that greater attention should be paid to such waste and its disposal.
In many cases, electrical and electronic waste is sent abroad to countries with less developed economies and used by the informal recycling sector (The Basel Action Network 2005). These cases trigger concern over environmental (Robinson 2009) and public health impacts (Perkins et al. 2014) caused by the hazardous materials contained within these types of equipment. Lack of coherence, ineffective enforcement strategy, as well as weak top-down approaches are regulatory issues that are identified as exacerbating the problems associated with electrical and electronic waste disposal (Widmer et al. 2005).

The aim of this article is to examine the effect of information on individuals' willingness to pay (WTP) for different electronic waste management strategies. We seek to add to the understanding of the problem of electrical and electronic waste disposal and to enhance the literature by seeking answers to two key questions: (1) Are consumers of electronic goods willing to bear the costs of proper disposal? and (2) To what extent does information influence electronic goods consumers' willingness to pay (WTP)? In order to determine the effect of information on WTP for electrical and electronic waste management, we present a study where the United Kingdom (UK) is the treated case and the null hypothesis is as follows: information has no effect on respondents' WTP.

In the remainder of Section I, we introduce important background to the electrical and electronic waste problem and areas of research that suggest paths to better addressing the associated challenges. In Section II, we provide our research methods. In Section III, we present the results of our econometric analysis. In Section IV, we describe the limitations of the study and areas for further research. In Section V, we provide concluding remarks and recommendations.

Electrical and Electronic Equipment Waste: A Fast Growing Waste Stream with High Economic Value, Limited Oversight, and Significant Risks

Electrical and electronic equipment waste, which includes computers, televisions, mobile phones and refrigerators, is expected to reach 12 million tonnes in the European Union by 2020 (European Commission 2015). This waste stream contains components and materials that have economic value (such as copper and the platinum group) when recycled (Basel Action Network 2005). However, what differentiates electrical and electronic waste from other waste is that the majority of the components and materials in the former contain hazardous materials (such as lead, PCBs, PBDE) that cause adverse effects to the environment and public health (Perkins et al. 2014). Furthermore, most electrical and electronic waste is disposed of in landfills, as effective reprocessing technologies that recover the

[2] Please note that at the time of the two publications cited here, the United Kingdom was part of the European Union.

valuable materials with minimal environmental impact are usually expensive (Robinson 2009). This lack of cost-effective and environmentally responsible reprocessing options poses a problem as it creates negative environmental impacts not only to surrounding soil, but also to water sources and the atmosphere when toxic materials are leaked during the burning process (Baldé et al. 2015).

Furthermore, as much of the electrical and electronic waste generated by consumers in developed economies is illegally exported to countries such as India, Ghana, or Nigeria, where it is treated in way that harms local populations, (J. Li et al. 2013) questions of global environmental responsibility and justice arise.

Legislative Attempts to Limit the Illegal International Trade of Electrical and Electronic Equipment Waste

The European Union has enacted legislation to address current increases in electronic waste, including the Waste Electrical and Electronic Equipment (WEEE) and the Restriction of Hazardous Substances (RoHS) directives. These directives aim to alleviate negative environmental impacts of electrical and electronic waste management processes (Baird, Curry, and Cruz 2014) and largely place the responsibility on manufacturers to cover the recycling costs of products they sell. In addition, the Basel Convention, which restricts the trans-boundary movement of hazardous wastes, including electronic waste between developed and developing economies, has been signed by the members of the European Union and UK as well as most developing economies.

Diverging national legislations, however, create gaps in the electrical and electronic management system. Namely, there is weak or non-existent national enforcement in many developing economies regarding electrical and electronic waste importation and imports. Taking the case of the UK, recycling facilities face serious logistical problems with the management of electrical and electronic waste, especially as there is insufficient storage space to hold waste before it goes into treatment (Altvater and Brandmann 2012). Such bottlenecks create an incentive for these recycling facilities to dispose of waste at cheaper prices by exporting to regions where environmental legislation is not as stringent.

In addition, donations of used and functioning electrical and electronic goods flowing from the UK and other developed economies to developing economies is a standard practice. The original aim of such transfers was to assist in the growth of technology markets. However, with the incentive for waste facilities to cut costs, the donation system has become corrupt and recycling plants are exporting obsolete electrical and electronic products (Perkins et al. 2014). This sub-optimal transfer of goods is further encouraged by recipient countries, where there is a high demand for inexpensive secondary products, given their potential to be a major source of income for poor, unemployed and low-skilled persons (Nnorom, Ohakwe, and Osibanjo 2008).

However, as these donated products cannot be sold on the second-hand electrical and electronic markets and recipient countries lack adequate infrastructure to manage electronic waste safely, the population who demands these products engage in crude recycling methods to extract valuable materials. These practices can be attributed to general low environmental awareness of the population engaging in these activities who must prioritize the meeting of basic needs (Nnorom, Ohakwe and Osibanjo 2007). The crude recycling is done in the form of open burning and dissolution in strong acids, which releases dangerous environmental contaminants. With few measures to protect human

health and the environment, such methods result in extreme localized contamination and migration of contamination into waters, soil and food chains (Nnorom, Ohakwe and, Osibanjo 2008). Electrical and electronic waste workers in these conditions suffer major negative health effects through skin contact and inhalation, although the long-term health effects are still unknown (Robinson 2009).
As new legislation attempts to institutionalize higher environmental standards for electrical and electronic treatment, costs of waste treatment increase, making illegal operations more attractive. Effective waste management in the UK and electrical and electronic waste recipient nations can facilitate returns of valuable resources into the economic product cycle, and also improve the health and environment created by unsafe waste management. However, to assist in a transition to this outcome, funding is required (Ongondo, Williams, and Cherret 2012), and, in a highly competitive electronic market, producers are reluctant to increase what is included in their costs in order to maintain lower standard prices. The incentive for contractors to undercut legal and safe waste processing operators is strong, as they can achieve savings of 200-300% with the exportation of electronic waste (Ongondo, Williams, and Cherret 2012) and producers are not shying away with their demand. Furthermore, waste producers are also not directly involved in the services provided by their waste contractors, which contributes to a lack of awareness and weak potential for prevention.

The UK recycling facilities are not sufficient to meet the demands of increasing electrical and electronic waste and this has resulted in illegal waste management of these materials, and the threat of environmental and health damages. As present legislation has not alleviated these issues, and costs to producers and manufacturers remain a major barrier, a complementary market-based mechanism is necessary to allocate these costs in an optimal way. Following the "polluter pays principle", the costs of electrical and electronic waste could be transferred to the end-users of the products and internalized within the product's life cycle. For these reasons, we chose the UK as a case study to begin exploring the question of WTP for different electronic waste management strategies.

Changing Behaviours and Transitioning to a Circular Economy
Market-based instruments, such as pollution taxes and subsidies, are often used to address the problem of so-called market failure and are deemed efficient due to their ability to incentivize reductions in emissions to a predetermined level at minimum abatement costs (Norregaard and Reppelin-Hill 2000). An electrical and electronic waste tax is one example of a market-based instrument used to address market failures within the electronic industry, whereby a fee is imposed by the government on new purchases of electronic products.

Several countries have already successfully implemented taxes on consumers' purchase of electronic products; specifically, countries such as Japan (Chung and Murakami-Suzuki 2008) and Ireland (Davies 2007). Furthermore, waste taxes have been reported to measurably affect consumers' waste disposal behaviour, (see, for example, Benoit 2004 for a study on solid waste taxes in Vermont). Such a tax can be used to pay for future recycling and recovery of electrical and electronic waste, as well as for funding infrastructure needed to transition to a circular economy. The circular economy, a concept which has gained significant attention in environmental and mainstream economic literature, can be described as an economy that "preserves and enhances natural capital, optimises resource yields and minimises systems risks by managing finite stocks and renewable flows." (EllenMacArthur Foundation 2017). The concept is relevant for the present study insofar as it focuses on the optimization of resource yields, which is also the underlying assumption and objective of the trade of electrical and electronical waste. This aspect of the concept means that circulating products, including

electrical and electronical, must be designed in order to be remanufactured, refurbished, recycled in order to "keep components and materials circulating in and contributing to the economy" (EllenMacArthur Foundation 2017). Building up the appropriate infrastructure, for collection and recycling for example, is a prerequisite to the mainstreaming of the circular economy. This concept associates the recycling of electrical and electronic waste with a larger paradigm shift. By introducing information about the circular economy, the present study aims at assessing UK end-users WTP for an approach that intends to address the resource optimization issue in a holistic way.

Behavioural Economics, Altruism, and the Willingness to Pay

Orthodox economic theory holds that the consumer is a rational, self-interested agent looking to maximize their preference-satisfaction (utility), and is consistent in their choices. Most policy designs from economists are based on this model of human behaviour (Henrich et al. 2001). In contrast, behavioural economics addresses the limitations of neoclassical economics in determining underlying motives of human behaviour. This alternative, which has gained a resurgence of attention in recent years, takes into account the social, cognitive, psychological and emotional factors that influence economic decision-making, such as altruism (Samson 2014).

Altruism broadly refers to actions motivated solely based on the utility and benefit of others, without receiving any personal utility from the action. Within the theory of altruism in behavioural economics, it is believed that the individual will get their preferences satisfied by consuming the 'good feeling' that giving to charity provides (Simon 1993). The value given by the natural environment or the well-being of others, are perceived as separate from the individual. Simply put, the individual gains, but not on the basis of monetary value (Johansson-Stenman 1998). In contrast, others such as White and Peloza (2007) conclude that altruistic behavior may be driven by the benefit to the self that is related to public self-image, rather than a motivation to help others benefit.

Previous studies have found that altruism influences responses in stated preference studies on values that are external to the person, such as the environment (Madariaga and McConnell 1987). Accordingly, the purchasing of pro-environmental products is perceived as altruistic, however as such products cost more than conventional substitutes, their purchase is seen as an increased willingness to pay for others' benefit (Grsikevicius, Tyber, and Van den Bergh 2010).

Values attributed to goods have also been found to increase under conditions of higher personal relevance; while, under conditions of lower personal relevance, the values are high when altruistic motives were introduced. The nature of the information provided in the contingent market, however, can have strong effects on WTP estimates, creating biased estimates, particularly in conditions of low personal relevance (Ajzen, Brown, and Rosenthal 1996).

In 2017, the OECD reviewed policy interventions that try to tackle environmental problems using behavioural insights. Among the areas explored, the review looks at the behavioural interventions implemented to improve waste management and resource efficiency policies. The policy interventions targeted a specific set of behavioural biases that affect individual choices relative to "*waste generation, sorting and recycling, as well as product reuse*" (OECD, 2017). The policy interventions reviewed have mainly relied on "the framing and simplification of information" (labelling) and "the changes to the physical environment" (signs describing the correct disposal) when dealing with resource efficiency and waste management. The following section takes a closer look at information's

effect on consumer behaviour, in particular when it comes to the sustainable consumption of electrical and electronic goods.

Information Effects on Consumer Behaviour

Increased information and understanding of a particular cause for donation, such as through the use of imagery or scenario, has shown to have an increasingly positive effect on an actor's desire to support the cause (Hung and Wyer 2009). In addition to information facilitating increased awareness, the method used to disclose the information also influences the valuation processes of non-market goods; as shown by Tkac (1998) in his study treating endangered species.

Several psychological studies have also shown that information available to an individual can influence not only their valuation processes, but also their attitude toward a particular contested issue (Lange et al. 2002; Gao and Schroeder 2009; Napolitano et al. 2010). Similarly, according to Bateman and Mawby (2004), additional information about the less familiar non-use aspects of an environmental good can result in an increase in the stated value of the good. This additional information can be, for example, about environmental resource quality.

Cameron and Englin (1997) show that information can influence contingent valuation estimates for environmental goods. They demonstrate that respondents' familiarity, experience, and information about the environmental good affect the valuation of the environmental good. In their study, individuals start the valuation process in contingent valuations without a clear prior idea of their WTP value.

Beyond the valuation aspect, information can directly affect consumers behaviour. One of the most relevant behavioural biases influencing consumer decisions is *status-quo bias*, which refers to the consumer tendency to select default or standard options. A study by Steffansdotter et al. (2016), commissioned by the Nordic Council[3], explored the use of behavioural techniques to incentivize a "*sustainable consumption of electronic good"*. Sustainable consumption refers here to the choice of reuse, recycling or the purchase of long-living models.

The Steffansdotter et al. (2016) recognises that consumer behavioural might depend on demographic factors as well as the specific electrical and electronic good. The study therefore focuses on mobile phone consumers aged between 19 and 28 and living in Nordic countries. It surveyed Danish electronics shop consumers that initially intended to replace broken phones and was based on two stated choice experiments that both changed the default option. The first presenting consumers with the possibility of repairing their phone, or buying a used phone, as opposed the buying a new one. The results showed that 87 percent of respondents would opt for the repair option if it was available in the store (20 percentage points more than in the baseline scenario). The second choice experiment attempted to encourage users to choose to lease their mobile, instead of buying a new one, through introducing a third "*clearly undesirable option (a more expensive leasing option)"*. As a result, 62 percent of the consumers chose to lease their phones, 24 percentage points above the baseline scenario. All these results were statistically significant and indicated that young consumers would consider sustainable consumption options when it comes to mobile phones.

[3] http://www.norden.org/en/nordic-council

When it comes to the sustainable consumption of electronic goods another possible choice is to select long-living products. A study by the European Economic and Social Committee (2016) assessed, through a stated choice experiment, the extent to which consumer choices would be affected by lifespan labelling – the study highlighted the information asymmetry between consumer and producers regarding products' lifespan. The study presented the consumers with four different visual displays for nine categories of products in four different geographies. It showed that lifespan encourages the purchasing of long-living products.

The above research indicates that the respondents' preference is constructed during the valuation process. Information plays a particularly relevant role in this process for non-use characteristics of environmental goods, as well as any aspect with which the respondents are not familiar or have limited prior information.

In the context of electronic and electrical waste, information has also proven to be influential in steering consumers toward sustainable behavioural. The question is whether or not it is going to have the same effect on consumers' willingness to pay for solutions that address the electrical and electronical waste issue. It is important to distinguish the role of information in reducing behavioural bias in the behavioural insight-based policies mentioned above, and its impact on willingness to pay.

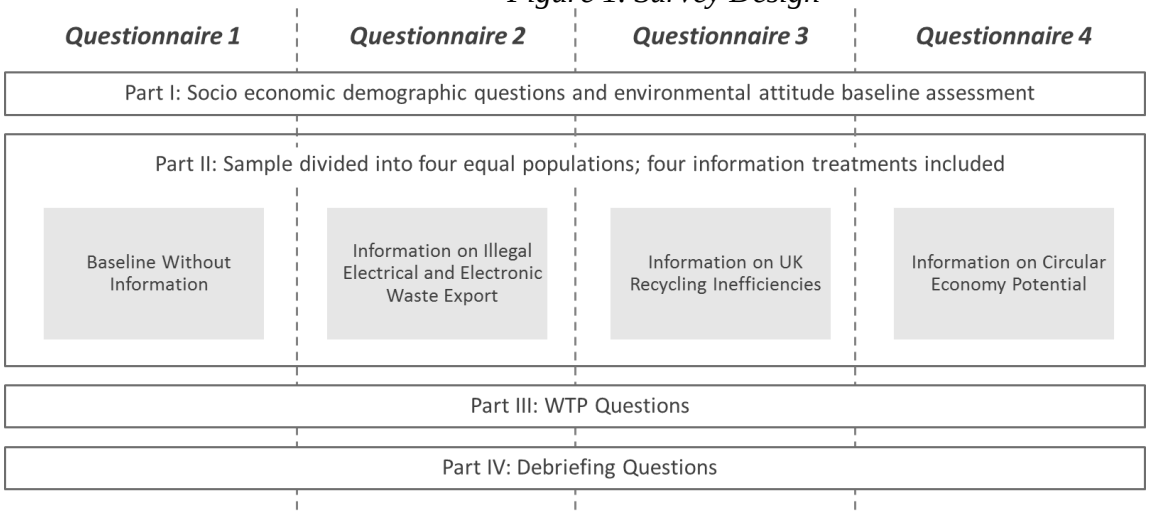
II. Research Methods

Experimental Survey and Design

For our study, we use an online survey (generated and powered by Qualtrics) to gather data. We distributed the survey to respondents via a third party panel company. The aim was to get 500 responses, a representative UK-wide sample. The survey includes introductory questions eliciting gender, age, employment status and environmental awareness. The question regarding employment status is used as a proxy for income, as consumers are more inclined to disclose their employment status rather than level of income. Debriefing questions are included in the final section of the survey to ascertain the reasoning for given responses and gain access to opinions on the scenarios provided. The debriefing questions and environmental awareness questions employ a 5-point Likert scale, with response options ranging from "strongly disagree" to "strongly agree."

Four different information treatments were designed (Figure 1). The first treatment is a baseline treatment, with limited information on electrical and electronic waste. The second treatment informs respondents that the tax would contribute to improving UK recycling facilities to become more efficient. The third treatment informs respondents about illegal exportation of electrical and electronic waste that is causing environmental and health damages abroad, and communicates to respondents that the waste tax would contribute to alleviating such damage. Finally, the fourth treatment describes the concept of a circular economy and explains that the waste tax would contribute to initial investments in such an economy.

Figure 1. Survey Design



Contingent Valuation Method (CVM)

Qualitative data was collected using the contingent valuation method (CVM) by conducting a survey. A payment card was given to respondents in order to elicit their WTP for different electronic waste management scenarios. This method was chosen to obtain the WTP for a non-market good, using a waste tax as a payment vehicle. Therefore, hypothetical markets had to be created with the descriptions outlined below. As in most contingent valuation studies, respondents often have little, if any, prior experience with the proposed good or service (Ajzen, Brown, and Rosenthal 1996).

Four different survey questionnaires were used, each outlining a hypothetical market, as indicated in the table below.

Table 1 - Hypothetical Markets Used for the Different Survey questionnaires

Questionnaire	***Hypothetical Market Description***
1) Baseline; Limited Information	*"…a significant proportion of the electronic waste generated in the UK is exported abroad for reuse and recycling. The UK government is designing an electronic waste management policy to improve the country's facilities for properly recycling electronic waste. As a result, laptop manufacturers will be required to add the associated costs to the price of their products, in the form of a waste tax. The implementation of this new waste tax will raise the price of your next laptop purchase."*
2) Information on UK Recycling Inefficiencies	*"The UK government is designing an electronic waste management policy to improve recycling facilities in the developing countries that import used laptops and electronic waste. As a result, laptop manufacturers will be required to add the associated costs to the price of their products, in the form of a waste tax. This waste tax will contribute to improving electronic waste recycling facilities in recipient nations, and therefore improving human and environmental health of those managing the waste."*
3) Information on Illegal Electrical and Electronic Waste Export	*"The UK government is designing an electronic waste management policy to improve the country's facilities for properly recycling electronic waste. As a result, laptop manufacturers will be required to add the associated costs to the price of their products, in the form of a waste tax. This waste tax will contribute to improving facilities and expanding space to meet the increased demand of electronic waste collection."*
4) Information on Circular Economy Investment	*"The UK government is designing an electronic waste management policy to improve the country's recycling facilities, with the goal of transitioning to a circular economy. As a result, laptop manufacturers will be required to add the associated costs to the price of their products, in the form of a waste tax. The waste tax will fund the infrastructure for the circular economy described above."*

In order to elicit the respondents' WTP, a payment card method was used for each treatment. Payment cards generate fewer outliers than open-ended questions (Bateman and Mawby 2002), but have limitations, such as starting point bias, due to the amounts provided on the cards. The design of the payment card is as follows: The survey respondents are asked to state the maximum value that they are not willing to pay for the waste tax, as well as the minimum value that they are willing to pay.

The values used on the payment card were chosen using the following rationale. According to CalRecycle (2015), the average cost of recycling a laptop is US$4 (hereafter $), and using the currency converter XE (2016) to account for income adjustment in the UK, the average estimated cost of recycling a laptop in the UK would be GB£2.77 (hereafter £) . This figure is used as a lower end value in the payment card, stated as £3. In an article by Moriarty (2016), electrical goods companies in the US charge a fee of $25 to recycle used electronic goods, such as TVs and laptops. We again used the currency converter XE (2016) to adjust the figure for the UK, finding that UK consumers would have

to pay a £17.35 recycling fee to recycle their laptops. This latter value was used as the higher end value on the payment card rounded up to £20. Thus, the range of numbers on the payment card includes the following values: £0, £3, £8, £14, £20.
The £0 value was included in order to single out the protest responses, and we included a section to allow respondents to state why they selected £0. According to Ryan and Watson (2009), it is important to identify protest responses and remove them from the analysis. In addition, a section was added in each scenario asking respondents who selected £20 if they are willing to pay more than £20, and if so, the total amount.

Estimating Willingness-to-Pay and Information Effects
To obtain our willingness-to-pay (WTP) value, we used the median WTP values from the payment cards. Furthermore, in order to test the significance of the effects of information on WTP, we used the following function:

WTP = F(Age, Gender, Employment Status, Laptops, Environmental Awareness Indicator, Information) .

We also used the following additional function to assess the impacts of the independent variables (socio-economic characteristics) for each of the treatment effects:

WTP = F(Age, Gender, Employment Status, Laptops, Environmental Awareness Indicator) .

Environmental Awareness Indicator

The environmental awareness indicator was constructed to capture respondents' attitudes toward the environment and awareness of electronic waste management strategies. It is also used to analyse data to understand the variable's effects on WTP. The indicator was developed utilising the individuals' responses that indicated the extent to which they agree with pro-environmental statements and environmental behaviour, as well as their responses to questions on overall environmental awareness.
For the environmental awareness questions, respondents indicated the extent to which they agreed with six statements. A Likert scale, ranging from one to five, was used to capture individual attitudes toward general environmental concerns. In addition, the respondents answered two questions assessing their knowledge of the end-of-life processes of their laptops.

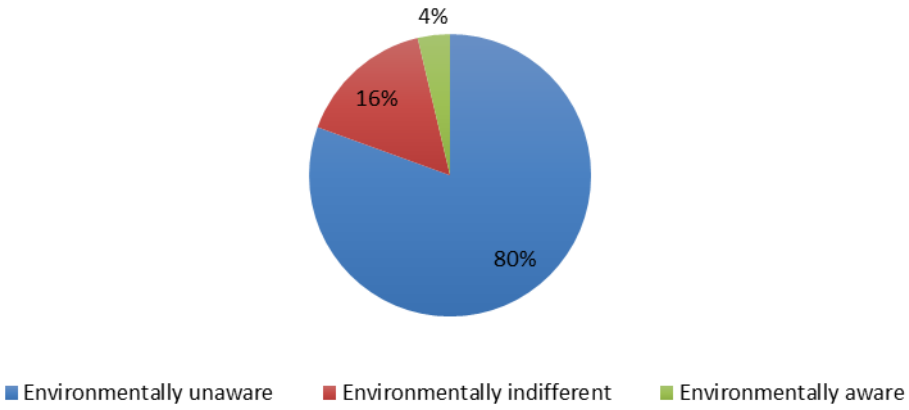
To derive the environmental awareness indicator, each question in the environmental awareness section was reflected through a function. The function is as follows:

$$\mathbf{E_n = (\sum k\ (a_{nk} - a^*))/K + A_n + B_n}$$

where n is the environmental awareness indicator for the **n**-th respondent, $\mathbf{a_{nk}}$ represents the number associated with the **n**-th individual response to the **k** statement, **a*** is the midpoint of each Likert scale, and K is the total number of statements. $\mathbf{A_n}$ and $\mathbf{B_n}$ represent the two additional questions on respondents' knowledge of laptops' end-of-life.

Figure 2 indicates the environmental awareness results of the respondents.

Figure 2. Environmental Awareness Indicator



Semi-Structured Interview

Semi-structured interviews were carried out as a diagnostic tool to add more information and depth to how the responsibility of the consumer is perceived. We mapped out experts' responses regarding the electrical and electronic waste management industry in the UK. These included:

- Extended Producer Responsibility (EPR) and WEEE Experts
- WEEE Regulation Authorities
- WEEE Professional Association

In a semi-structured interview, the interviewer develops and uses a list of questions and topics, but is able to stray from the guide when he or she feels appropriate (Cohen and Crabtree 2006). Most of the questions asked are open-ended, such as: "How does the WEEE management being carried out in the UK?" or "Why isn't e-waste in the UK segregated within the household level?" Open-ended questions are used, rather than close-ended questions, to get lengthy and descriptive answers.

Prompts are also used within the interview to encourage people to expand on topics of interest and to probe more information when the responses are unclear. The prompts are not scripted because every interview is different and the list of possible probes is unlimited (Leech 2002). Examples of the prompts include reassuring noises and interjections that people make during any conversation to show that they are listening and interested, as well as repeating the key term of the respondent's last remark as a question.

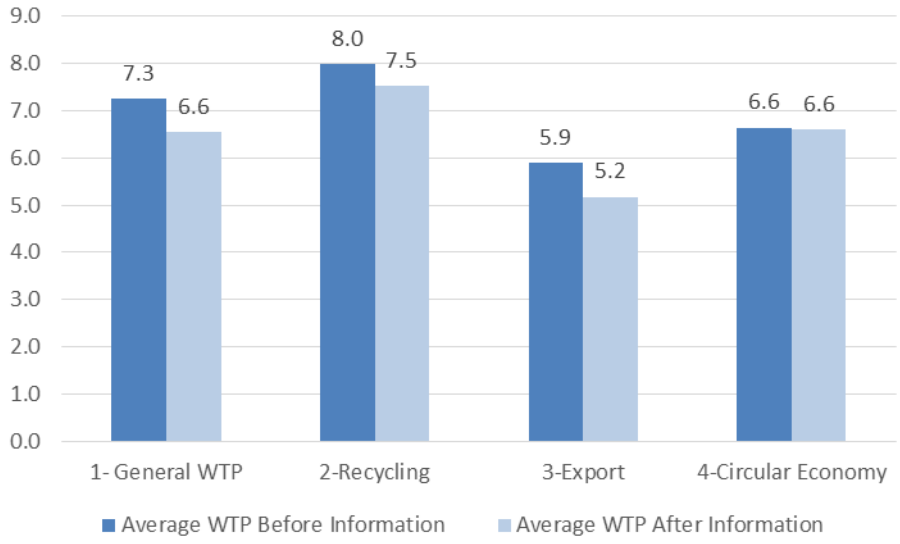
The interviews were used to inform the contingent valuation study, and to support and analyze the results.

III. Results: The Effect of Information on the Willingness to Finance Electrical and Electronic Equipment Waste Management Strategies at Home in the UK and in Recipient Countries

Information Effects on Willingness-to-Pay

Figure 7 shows that the median WTP varied between information treatments. For treatments 1, 2 and 3, the median WTP decreased once the information for each treatment was given. For treatment 4, there was no change in the stated WTP.

Figure 3. Average Willingness-to-Pay



Regressions and Willingness-To-Pay Results

Two econometric models were used to test the significance of the results. The first model, "*Determinants for Each Scenario*" section, assessed the relationship between the socio-economic characteristics and environmental awareness on WTP for each treatment, and the second model, "*Determining Information Effects*" section, assessed the relationship between information and WTP for the entire data set. The independent variables were both continuous and categorical. The categorical variables included age, gender, employment status and environmental awareness; where a number was assigned to each category. The only continuous variable in our analysis was number of laptops. The dependent variable used was median WTP. The regressions were run using the data analysis and statistical software Stata.

Determinants for Each Scenario

For each treatment, the following linear regression equation was used to observe and test the significance of the socio-economic characteristics and environmental awareness on WTP:

$$Y = \alpha + \beta_1\chi_1 + \beta_2\chi_2 + \beta_3\chi_3 + ... + \beta_i x_i$$

$$WTP_{Treatment} = \alpha + \beta_1 Age + \beta_2 Gender + \beta_3 Job + \beta_4 Laptops + \beta_5 Awareness$$

The results are depicted in Tables 2, 3, 4, and 5.

Table 2. Regression on Treatment 1 [General WTP Scenario]

Variables	Coefficients	P > | t |	Standard Error	95% CI	
Below 20	0		(base)		
20-30	3.11	0.26	2.72	-2.29	8.50
31-40	1.89	0.52	2.95	-3.95	7.72
41-50	1.97	0.50	2.90	-3.77	7.72
51-60	3.59	0.22	2.91	-2.18	9.36
Above 60	2.73	0.38	3.07	-3.35	8.82
Male	0		(base)		
Female	0.83	0.41	1.00	-1.15	2.81
	1.00				
Unemployed	0		(base)		
Student	1.23	0.52	1.88	-2.49	4.94
Part-time Employment	0.77	0.61	1.49	-2.18	3.72
Full-time Employment	2.56	0.02	1.06	0.46	4.66
Retired	2.35	0.14	1.60	-0.81	5.52
Laptops	-0.01	0.97	0.32	-0.64	0.61
Environmentally Unaware	0		(base)		
Environmentally Indifferent	-1.92	0.14	1.31	-4.51	0.67
Environmentally Aware	0.13	0.87	0.82	-1.50	1.76

In Treatment 1 (baseline with limited information), there was one statistically significant coefficient, which was employment status, more specifically category 4, where $P>|t| = 0.017$ [$<p = 0.05$]. Category 4 was the number assigned to respondents in full-time employment. This indicated that there is a positive correlation between respondents in full-time employment and WTP. In addition, the result indicates that a one unit increase in full-time employment, results in a 2.56 unit increase in WTP. This is derived from the coefficient value.

Table 3. Regression on Treatment 2 [Recycling in the UK Scenario]

Variables	Coefficients	P > | t |	Standard Error	95% CI	
Below 20	0	(base)			
20-30	-10.67	0.09	6.19	-22.93	1.60
31-40	-8.26	0.20	6.37	-20.88	4.37
41-50	-7.87	0.22	6.37	-20.50	4.75
51-60	-9.81	0.12	6.31	-22.30	2.69
Above 60	-6.40	0.32	6.35	-18.99	6.18

Male	0		(base)		
Female	3.36	0.00	1.14	1.11	5.61
Unemployed	0		(base)		
Student	2.03	0.55	3.37	-4.65	8.70
Part-time Employment	-0.72	0.71	1.94	-4.57	3.14
Full-time Employment	0.58	0.71	1.58	-2.55	3.71
Retired	-1.41	0.51	2.12	-5.62	2.80
Laptops	-0.12	0.76	0.41	-0.94	0.69
Environmentally Unaware	0		(base)		
Environmentally Indifferent	-1.46	0.30	1.40	-4.24	1.32
Environmentally Aware	-1.74	0.13	1.13	-3.98	0.50

Regarding Treatment 2, the statistically significant coefficient is gender, category 1 (females), where P>|t| = 0.004 [<p = 0.05]. Indicating a positive correlation between respondent's being female and WTP. Moreover, the results suggest that with one unit increase in females would result in positive 3.36 unit increase in WTP.

Table 4. Regression on Treatment 3 [Illegal Exportation of E-Waste Scenario]

Variables	Coefficients	P > | t |	Standard Error	95% CI	
Below 20	0		(base)		
20-30	3.76	0.30	3.60	-3.37	10.88
31-40	3.40	0.36	3.71	-3.95	10.74
41-50	4.74	0.21	3.78	-2.75	12.22
51-60	5.49	0.15	3.77	-1.97	12.96
Above 60	6.71	0.10	4.04	-1.29	14.71
Male	0		(base)		
Female	2.45	0.07	1.31	-0.16	5.05
Unemployed	0		(base)		
Student	6.23	0.04	2.93	0.42	12.04
Part-time Employment	1.15	0.59	2.10	-3.01	5.31
Full-time Employment	1.88	0.21	1.48	-1.06	4.82
Retired	1.24	0.54	2.01	-2.74	5.23
Laptops	0.36	0.21	0.29	-0.21	0.94
Environmentally Unaware	0		(base)		

Environmentally Indifferent	1.82	0.23	1.52	-1.19	4.82
Environmentally Aware	-0.46	0.65	1.03	-2.51	1.58

Interestingly in Treatment 3, the statistically significant coefficient, was employment status category 2, which were students; where P>|t| = 0.036 [<p = 0.05]. This implies a positive correlation between students and WTP; and that with one unit increase in students, there is a positive 6.23 unit increase in WTP.

Table 5. Regression on Treatment 4 [Circular Economy Scenario]

Variables	Coefficients	P > | t |	Standard Error	95% CI	
Below 20	0		(base)		
20-30	0.42	0.90	3.20	-5.92	6.76
31-40	0.36	0.92	3.61	-6.80	7.52
41-50	-0.76	0.83	3.62	-7.94	6.42
51-60	-0.05	0.99	3.62	-7.21	7.11
Above 60	-0.60	0.88	3.89	-8.30	7.10
Male	0		(base)		
Female	2.75	0.07	1.50	-0.22	5.73
Unemployed	0		(base)		
Student	-0.88	0.77	3.03	-6.88	5.12
Part-time Employment	0.19	0.92	1.92	-3.62	4.01
Full-time Employment	0.55	0.72	1.52	-2.46	3.55
Retired	0.85	0.71	2.25	-3.61	5.31
Laptops	1.59	0.00	0.49	0.61	2.56
Environmentally Unaware	0		(base)		
Environmentally Indifferent	-2.33	0.09	1.36	-5.03	0.37
Environmentally Aware	-0.83	0.44	1.08	-2.97	1.30

In Treatment 4, the coefficient which is statistically significant is the number of laptops per household, where P>|t| = 0.002 [< p = 0.05]. The results indicate that there is a positive correlation between number of laptops per household and WTP. Furthermore, one unit increase in the number of laptops per household will positively impact WTP for the circular economy by 1.58 units.

Determining Information Effects

To further assess the impacts of information on willingness to pay, the information treatments were added to the following linear regression equation:

$$Y = \alpha + \beta_1\chi_1 + \beta_2\chi_2 + \beta_3\chi_3 + ... + \beta_i x_i$$

$$\mathbf{WTP_{Total} = \alpha + \beta_1 Age + \beta_2 Gender + \beta_3 Job + \beta_4 Laptops + \beta_5 Awareness + \beta_6 Information.}$$

The results are depicted in Table 1. The information scenarios, which showed a positive correlation between information and WTP, were treatment 2 and 4 (P>|t| = 0.012 [< p = 0.05] and P>|t| = 0.05 [<p = 0.05] respectively). Treatment 2 disclosed information on enhancing recycling facilities in the UK, and Treatment 4 disclosed information on investing toward a circular economy. Thus, one unit increase in information regarding recycling in the UK would increase WTP by 1.62 units, and one unit increase in information on the circular economy would also increase WTP by 1.24 units.

Table 6. Information Regression on Willingness-To-Pay

Information Treatment	Coefficients	P > | t |	Standard Error	95% CI
Baseline without Information	**0 (base)**	-	-	-
Information on UK Recycling Inefficiencies	**1.61836**	0.012	0.643	[0.354 ; 2.882]
Information on Illegal E-waste Export	**-0.44027**	0.487	0.632	[-1.682 ; 0.802]
Information on Circular Economy Potential	**1.235657**	0.05	0.627	[0.0018 ; 2.469]

Interview Results

Semi-structured interviews were carried out with experts of the WEEE industry. The most significant finding was that consumers are largely unaware of their role and the responsibilities that come with it. This is particularly problematic in the case of small WEEE, including laptops, as consumers are relied upon to bring their WEEE to collection points. However, for the consumer, this is neither efficient nor cost effective.

Absence of communication is believed to be the cause of low consumer awareness. This might have negative implications on their WTP for visible fees, such as a waste tax. Consumers would not agree to these imposed costs as they would view them as outside of their scope of responsibility, and that it is the responsibility of the producers to cover these costs.

Discussion

The median WTP results for all information treatments demonstrate a decrease in median WTP the second time the respondents were asked their WTP for a tax. This may be due to the respondents' negative perceptions toward tax and the overall presentation of questions in the survey.
The regression analyses demonstrate positive correlations between information Treatment 2 and WTP and information Treatment 4 and WTP. Treatment 2 included information on how the tax is needed to address recycling facilities in the UK, and Treatment 4 outlined how tax can be used to transition to a circular economy in the UK. As correlation does not prove causation, we hypothesize that the results described above may be due the fact that they are of high personal relevance, as our sample based in the UK. Respondents willingness to pay for personally relevant scenarios supports the neoclassical assumption that an agent is rational and out to maximise his own utility.

There is no correlation between the information provided in Treatment 3 and WTP. This may be due to the fact that it was of low personal relevance to respondents. The resulting benefits of the tax will

not be experienced by the consumer and it is likely that they do not feel it is their responsibility to address this problem. That respondents do not believe they should be responsible was indicated in their responses when asked why they chose £0 on the payment card. Therefore, the results do not demonstrate any intention for altruistic behaviour.

The qualitative results support these findings, reasoning that the low general WTP for the waste tax is due to the lack of consumer awareness of their role in the disposal of electronic waste.

IV. Limitations of the Study and Potential for Further Research

Limitations of the Study

As with most studies, this study is not without limitations. The biggest limitation to the study is that the respondents in each treatment group are not a representative sample of the UK population. This is due to the fact that the total number of respondents, which is a representative sample, was split into four treatment groups. Additionally, the sample was obtained through a third party panel company, using paid respondents to answer the questionnaire, potentially introducing strategic bias.

In terms of representation, it is important to note how the sample population demographics compare with the UK population. A large proportion of our sample is unemployed: 15% compared to 5.1% of the general population (Office for National Statistics 2016). Other differences include: 22% of the sample is in retirement compared to 13.1% throughout the UK; 47% of the sample is in full-time employment compared to 74.1% for the UK population. Despite these differences, however, the sample's average number of laptops per household is similar to the UK average of 1.3 (The Guardian 2015).

In order to improve the reliability of our results, it is necessary to increase the number of respondents in all information treatments. In addition, we did not clarify if our respondents were solely responsible for purchasing their laptops or whether they were purchasing a laptop in the near future; therefore, we cannot ensure their stated preferences reflect their true consumer behaviour. Furthermore, there is no data available on the UK population's environmental awareness levels as measured in our environmental awareness indicator, which combines environmental attitudes and awareness of electronic waste management processes. Such information would be helpful in determining the extent to which our sample is representative. Instead, our analysis included an environmental awareness indicator that we developed. Respondents were categorised according to levels of environmental awareness, and the distribution of respondents within these categories would have been different depending on the choice of methodology (thresholds).

Our survey methods were inherently biased due to the challenges in the creation of hypothetical markets. The biggest flaw in the hypothetical markets used was the use of the term "waste tax". Studies have shown that taxes can induce negative responses. Our survey findings from the open-ended debriefing questions strongly demonstrated negative responses to taxes. Our qualitative findings also support this, where it was discovered that the perception of a hypothetical market with "increased prices" or a less visible cost may have resulted in more neutral responses. It was difficult to objectively measure and assess the level of neutrality of the hypothetical markets provided and assess uncontrolled responses, regardless of omitting any explicit emotional or influential language. In real life market transactions, people usually face discrete choices. Hannemann's (1994) study on contingent

valuation showed that open-ended willingness-to-pay questions are more difficult for respondents than closed-ended ones. Also, when people are asked twice about their WTP, they may lose trust in the survey, as it may seem less realistic and less reliable.

The aforementioned limitations were addressed in the debriefing section of the survey. Validation questions were included to test for protest zeros, bias, and to check the respondents' understanding and acceptance of the key parts of the valuation scenarios provided. These questions also probed the respondents' motives behind their answers. From this, we negated any responses that showed lack of understanding, "yes-sayers" and protest zero responses. However, as we carried out the survey online, we were unable to gage the respondents' emotions toward the tax before and after the information effect. Assessing respondents' emotional response may have been more effective if the information was handed out in person directly, as well as if the survey had been carried out in a workshop.

Our study uses values based on individual laptop recycling costs outside of the UK, as there was insufficient UK data available. Although adjusted for income using current exchange rates, it may not reflect the true value recycling costs for the UK. Additionally, the waste tax value was solely determined by recycling costs; it was not increased to retroactively include cost recovery for environmental damage, caused by the current insufficient facilities in the UK or abroad. Therefore, the values used may not reflect reality.

Finally, the level of information in each scenario was not quantified. The respondents' answers might be impacted by the difference in each scenario from a pure quantitative stand point.

Potential for Further Research

In light of the current study's limitations and findings, follow-up study topics to expand findings could first include an in-depth study on consumer awareness of their roles in the electronic waste disposal process. It would also be beneficial to repeat the study with a modified hypothetical market, using other payment vehicles instead of a "waste tax". Such a study would explore the subject without the bias linked to the use of the vocabulary on tax. Similarly, a comparison of responses with the use of varied levels of persuasive and emotive language in the information provided, as well as different types of visual aids, would explicitly enrich research on altruism theory. Finally, replicating the study outside the UK would be helpful in understanding the cultural dimension related to the management of electronic waste and its economic geography.

V. Conclusions and Recommendations

The findings of this study show a decrease in median WTP after information was provided in each treatment. However, the results from the regression analysis suggest a positive correlation between information and WTP. Therefore, this study is able to reject the H1 hypothesis and confirm that information has an effect on the survey respondents' willingness to pay a waste tax in order to address electrical and electronic waste issues.

Regarding the H0 hypothesis focusing on the willingness to pay for the cost of proper disposal of electrical and electronic waste, the results are nuanced. The results show that respondents are only willing to finance strategies that are targeted to the UK context directly relevant to respondents.

In addition, the studies introduced the concept of circular economy in order to assess the respondents' willingness to pay for an approach that intends to address the resource optimization issue in a holistic way. In particular, the possibility of using such a waste tax to support the transition to a more circular economy. We strongly conclude that an awareness effort must be deployed before implementing such a model.

Public awareness campaigns should, therefore, be launched. These campaigns should be personally relevant to the consumer, and provide information on the consumer's role in the electronic waste disposal chain, the countries waste management system and the benefits of transitioning to a circular economy.

In the light of the study's nuanced results, it is important not to jump to the tempting conclusion that *consumers from developed economies are not concerned with the health and environmental impact their electrical and electronic waste is having on host countries*. First, the payment vehicle, the "tax", used for the study can be controversial as respondents may be unwilling to pay an additional tax in a context dominated by fiscal pressure; especially when the proceeds are financing facilities in a different country. Second, the scenarios provided during the study deliberately avoided excessive emotional language; it is possible that providing images and other visual material on the environmental and health impact of illicit electronic waste trade will have a different impact on respondents' willingness to pay. Finally, only 4% of the respondents were aware of their role in disposing of electronic waste and where it goes; a sample with a higher awareness level might also approach the survey in a different way.

Still, as mentioned in the introduction of the paper, the fact that electrical and electronical waste is illegally moved from "source" developed economies to "host" developing economies (J.Li et al., 2013) raises the questions of global environmental responsibility and social justice. Implementing the awareness campaigns we suggest, and raising the level of information, requires coordinated action across the spectrum, an effort that proves to be challenging.

Ultimately, what WEEE choose to do in the UK and beyond, remains an open question, but not one without consequences. How we inform our decisions will be key.

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Appendix
STATA REGRESSION RESULTS
Regression Treatment 1: General WTP Scenario

MedianWTPAfter	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Age						
1	0	(base)				
2	3.107772	2.723817	1.14	0.256	-2.287585	8.50313
3	1.888841	2.945368	0.64	0.523	-3.945367	7.723049
4	1.974472	2.902333	0.68	0.498	-3.774491	7.723436
5	3.590739	2.912381	1.23	0.220	-2.178128	9.359606
6	2.732451	3.071533	0.89	0.376	-3.351665	8.816567
Gender						
0	0	(base)				
1	.8306313	1.000205	0.83	0.408	-1.150582	2.811844
Job						
1	0	(base)				
2	1.226647	1.876249	0.65	0.515	-2.489842	4.943136
3	.7698741	1.487239	0.52	0.606	-2.176061	3.715809
4	2.559083	1.05938	2.42	0.017	.460654	4.657512
5	2.353861	1.596955	1.47	0.143	-.8093995	5.517121
Laptops	-.0127265	.3159152	-0.04	0.968	-.6384937	.6130406
Environmentalattitude						
0	0	(base)				
1	-1.921168	1.30604	-1.47	0.144	-4.508181	.6658452
2	.1322473	.8221947	0.16	0.872	-1.496362	1.760857
_cons	.9888904	3.045446	0.32	0.746	-5.043552	7.021333

Regression Treatment 2: Recycling in the UK Scenario

MedianWTPAfter	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Age						
1	0	(base)				
2	-10.66647	6.191669	-1.72	0.088	-22.93446	1.601532
3	-8.257085	6.370905	-1.30	0.198	-20.88022	4.366047
4	-7.872556	6.370612	-1.24	0.219	-20.49511	4.749995
5	-9.806775	6.307262	-1.55	0.123	-22.30381	2.690256
6	-6.402167	6.352148	-1.01	0.316	-18.98813	6.1838
Gender						
0	0	(base)				
1	3.358271	1.135844	2.96	0.004	1.107742	5.608799
Job						
1	0	(base)				
2	2.025027	3.367745	0.60	0.549	-4.647728	8.697783
3	-.7174409	1.944446	-0.37	0.713	-4.570112	3.135231
4	.5818682	1.578716	0.37	0.713	-2.546155	3.709892
5	-1.408134	2.123575	-0.66	0.509	-5.615725	2.799457
Laptops	-.1238836	.4121968	-0.30	0.764	-.9405987	.6928316
Environmentalattitude						
0	0	(base)				
1	-1.461436	1.401361	-1.04	0.299	-4.238054	1.315182
2	-1.738753	1.131878	-1.54	0.127	-3.981424	.5039183
_cons	15.71827	6.458645	2.43	0.017	2.921296	28.51525

Regression Treatment 3: Illegal Exportation of E-Waste Scenario

MedianWTPAfter	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Age						
1	0	(base)				
2	3.758694	3.596577	1.05	0.298	-3.366097	10.88349
3	3.399562	3.707626	0.92	0.361	-3.945217	10.74434
4	4.73516	3.7805	1.25	0.213	-2.753981	12.2243
5	5.493179	3.768765	1.46	0.148	-1.972716	12.95907
6	6.707393	4.037273	1.66	0.099	-1.290414	14.7052
Gender						
0	0	(base)				
1	2.446161	1.314831	1.86	0.065	-.1585084	5.05083
Job						
1	0	(base)				
2	6.229103	2.93197	2.12	0.036	.4208929	12.03731
3	1.150425	2.101393	0.55	0.585	-3.012417	5.313268
4	1.880397	1.484289	1.27	0.208	-1.059969	4.820762
5	1.243726	2.012409	0.62	0.538	-2.74284	5.230292
Laptops	.3647247	.2890524	1.26	0.210	-.2078859	.9373353
Environmentalattitude						
0	0	(base)				
1	1.817578	1.515971	1.20	0.233	-1.185549	4.820705
2	-.4637115	1.031664	-0.45	0.654	-2.50743	1.580007

Regression Treatment 4: Circular Economy Scenario

MedianWTPAfter	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Age						
1	0	(base)				
2	.4224239	3.200322	0.13	0.895	-5.916217	6.761064
3	.3596762	3.613166	0.10	0.921	-6.796655	7.516007
4	-.7599074	3.623941	-0.21	0.834	-7.937579	6.417764
5	-.0530883	3.615088	-0.01	0.988	-7.213226	7.10705
6	-.6003712	3.889793	-0.15	0.878	-8.304596	7.103854
Gender						
0	0	(base)				
1	2.752914	1.50155	1.83	0.069	-.221094	5.726923
Job						
1	0	(base)				
2	-.878252	3.028314	-0.29	0.772	-6.87621	5.119706
3	.1938771	1.924697	0.10	0.920	-3.618229	4.005983
4	.549518	1.517307	0.36	0.718	-2.4557	3.554736
5	.8488686	2.251653	0.38	0.707	-3.610814	5.308551
Laptops	1.588465	.4923801	3.23	0.002	.6132439	2.563686
Environmentalattitude						
0	0	(base)				
1	-2.32551	1.363361	-1.71	0.091	-5.025818	.3747974
2	-.8318855	1.078141	-0.77	0.442	-2.967279	1.303508
_cons	4.129898	3.954051	1.04	0.298	-3.701599	11.9614

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